

A NEW NEMATODE, RICTULARIA SPLENDIDA, FROM THE COYOTE, WITH NOTES ON OTHER COYOTE PARASITES.

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The coyote, as a carrier of parasites, may be looked upon, for most purposes, as a common dog running wild. All the available evidence indicates that parasites of either the coyote or the dog could certainly be transmitted, under favorable conditions, to the other animal. The parasites of the coyote have, therefore, practically the same considerable economic importance that those of the dog have. If they are detrimental to the coyote, it would be to our interest to see that they are permitted to thrive, provided it were feasible to do so. It is not always feasible or desirable, for the reason that the coyote may transmit such parasites, directly or indirectly, to dogs, to the injury of the dogs and of other animals in which some of these parasites may pass intermediate stages of their life-history.

Whether the parasite described below has any pathological, and hence economic, significance is not known. Its remarkable armature and mouth structure, and the fact that other species of the same genus have been reported as red when collected, a thing suggestive of a blood-sucking habit, indicate that the worm may be quite injurious to its host. On the other hand, species and specimens of the genus involved are comparatively rare, so that there is little evidence at present to show that the worm has any particular economic significance.

Superfamily STRONGYLOIDEA Weinland, 1858.

Superfamily diagnosis.—Meromyarian or polymyarian. Males with a caudal bursa supported by rays; in forms near the outer limit of the superfamily the bursa is occasionally very small and the rays atypical, or the bursa may be lacking altogether, the species in question being only referable to this superfamily on the ground that transitional, but recognizably strongyle forms, found at times in the same locations and with the same habits, relate them to it. Esophagus without posterior bulb. Mouth naked or with a buccal capsule and six papillæ

distinct or indistinct. Male usually with two spicules and female usually with two ovaries. Oviparous, viviparous, or ovoviviparous.

Type family.—Strongylidæ Cobbold, 1864.

Weinland proposed the Strongyloidea as a family, but the name is in the form now used for the superfamily and it is erected as a superfamily in this paper.

Family STRONGYLIDÆ Cobbold, 1864.

Family diagnosis.—Strongyloidea: Meromyarian. Caudal bursa well developed and with each lateral lobe supported by six rays. Buccal capsule present or absent; when present, slightly or well developed. Oviparous; eggs segmenting when laid. Embryo usually rhabditiform. In digestive, rarely in respiratory system.

Type genus.—*Strongylus* Mueller, 1780.

Subfamily STRONGYLINÆ Railliet, 1893.

Subfamily diagnosis.—Strongylidæ: Buccal capsule well developed. Parasites of the digestive, rarely of the respiratory tract.

Type genus.—*Strongylus* Mueller, 1780.

Subfamily TRICHOSTRONGYLINÆ Leiper, 1908.

Subfamily diagnosis.—Strongylidæ: Buccal capsule lacking or only slightly developed. Parasites of the digestive tract.

Type genus.—*Trichostrongylus* Looss, 1905.

Family METASTRONGYLIDÆ Railliet and Henry, 1910.

Family diagnosis.—Strongyloidea: Polymyarian. Buccal capsule present or lacking. Caudal bursa present or absent; when present, frequently atypical in structure and number of rays. Oviparous, with eggs in variable stages when laid, ovoviviparous or viviparous. Embryo not rhabditiform (not known for Rictulariinae). In respiratory and circulatory systems, rarely in digestive.

Type genus.—*Metastrongylus* Molin, 1861.

Subfamily METASTRONGYLINÆ Leiper, 1908.

Subfamily diagnosis.—Metastrongylidæ: Bursa well developed and conforming in general to the strongyle type. Eggs in varying stages of development when laid. In respiratory and circulatory systems.

Type genus.—*Metastrongylus* Molin, 1861.

Subfamily PSEUDALINÆ Railliet and Henry, 1909.

Pseudalinæ RAILLIET AND HENRY, 1910.

Subfamily diagnosis.—Metastrongylidæ: Bursa much reduced or lacking; when present, with few and atypical rays. Mouth with or without buccal capsule. Viviparous. Parasites of the respiratory and circulatory apparatus.

Type genus.—*Pseudalius* Dujardin, 1845.

I have followed Railliet and Henry (1910) in grouping the two subfamilies just given under the *Metastrongylidæ*, the family created by them for these subfamilies on the ground that they have the same musculature. It should be noted, however, that Schneider (1866) puts *Pseudalius* in the *Holomyaria*, which are related to the *Meromyaria*, and Railliet (1895) has listed *Pseudalius* as a meromyarian of holomyarian form. Not being in a position to pass on the question, I have followed Railliet and Henry.

Subfamily RICTULARIINÆ Hall, 1913

Subfamily diagnosis.—*Metastrongylidæ*: Bursa much reduced or lacking; when present, with few and atypical rays. Mouth with well developed buccal capsule. Prominent cuticular ornamentation along entire body. Ovoviviparous. Parasites of the digestive tract.

Type genus.—*Rictularia* Frölich, 1802.

This subfamily is proposed here for the reason that *Rictularia* can not be referred to any subfamily at present established. The structure of the mouth parts, the esophagus, the spicules and the ovaries relates it to the strongyles, although it does not have the normal strongyle bursa. The elaborate cuticular ornamentation and the fact that it is ovoviviparous are atypical conditions in the group to which it is referred. On the other hand, the buccal capsule which relates *Rictularia* to the *Strongyloidea* excludes it from any other group.

Genus RICTULARIA Frölich, 1802.

Generic diagnosis.—*Rictulariinae*. There is a well-developed, narrow, chitinous buccal capsule, with its aperture more or less distinctly dorsal and probably always surrounded by a cirlet of denticles, and with its base armed with teeth and spines. Esophagus without posterior bulb. Along practically the entire ventral surface on each side there are two rows of cuticular combs or spines. The vulva is near the posterior end of the esophagus. Male with or without a bursa, which when present is always small and always remains open, and with two small, equal or unequal spicules. Egg containing an embryo when laid. In the small intestine of bats, rodents, insectivores, and carnivores.

Type species.—*Rictularia cristata* Frölich, 1802.

The above generic diagnosis is a modification of that given by Jägerskiöld (1909) in his monographic paper on this genus. As Jägerskiöld points out, the description and figures of the type-species, *R. cristata*, do not agree with the generic diagnosis here given, in that *R. cristata* is described and figured by Frölich (1802), and the description confirmed by Dujardin (1845), as having only one row of ventral combs or spines. Jägerskiöld states that he would doubt Frölich's accuracy if Dujardin had not verified this description, and

that in case their descriptions are confirmed the generic diagnosis above given will need revision.

It seems that Jägerskiöld might have even gone further and said that if *R. cristata* were found to have only one row of ventral spines extending, as Frölich describes and figures it, from the head to the vulva, then it would be necessary to leave it as the type and only species of its genus and create a new genus for the several other species at present assigned to this genus and which have two rows of ventral spines or combs extending from the head practically the entire length of the body. There is, however, some little evidence for believing that Frölich and Dujardin were both in error in stating that *R. cristata* has only a single row of spines.

In the first place, it is a very easy matter to get the impression that a species of *Rictularia* has only a single row of spines. It was my own impression of *R. splendida* when I first looked at it. No other species of *Rictularia* was known to either Frölich or Dujardin, so they had no contradictory statements or material for comparison to make them particularly careful in regard to this point. Moreover, they worked at a time when nematodes were none too carefully described, and their descriptions of this species are in error in some other respects. More important yet is the fact that both of them have evidence in their papers that their statements in regard to the number and extent of the rows of spines is not correct. Thus Frölich states that there is but one row of spines, but his figure 3 of plate 1 shows the row of spines to be distinctly latero-ventral in its relation to the buccal capsule, and his statement in the label that the spines are turned sideways leaves it still likely that a corresponding row on the opposite side of the body was not seen. Dujardin offers confirmation of this idea when he states that the cuticle bears from the head to the vulva an asymmetrical rank of hooks. The suggestion of asymmetry probably arose from seeing both rows of hooks in the head region, where they were close together and yet evidently not in the same focal plane. Probably influenced by Frölich's statement and by his own first observation, he held to the idea that there was only one row, qualifying it to conform to other observations by the statement that the row was asymmetrical. Frölich apparently only saw one row and did not mention or figure any asymmetry. Dujardin also states that the vulva is located laterally toward the dorsal face (taking the position of the buccal aperture, which is dorsal, as determining the ventral surface), and it seems evident that he considered the ventral (to him dorsal) line as determined by the row of spines and the vulva at its side as located laterally or asymmetrically. The actual fact must have been that the vulva was in its usual approximate ventral location (it is a little lateral in *R. cahirensis* and

R. splendida) between the two latero-ventral rows of spines, of which he saw only the upper and nearer row.

In the second place, Frölich and Dujardin state that the row of spines extends from the head to the vulva, but Frölich adds that rarely one notices one or more teeth behind the vulva. In this connection it may be noted that the species of the genus *Rictularia* break rather naturally into two groups, (1) those parasitic in carnivores and in which the comblike cuticular structures of the anterior portion of the body of the female change very gradually into the spinelike structures of the posterior portion of the body, with no noticeable alteration taking place in the immediate vicinity of the vulva, and (2) those parasitic in rodents, insectivores, and bats, and in which the comblike structures anterior of the vulva become spinelike posterior of it, the transition being more or less marked in the vicinity of the vulva. The comblike structures are larger, continuous, and much more conspicuous; the spinelike are smaller, separated, often widely so, and in some cases very inconspicuous. The species which Frölich and Dujardin had, *R. cristata*, was collected from rodents, *Mus sylvaticus*, *Myoxus glis*, *M. nitidula*, and *M. avellanarius*, and probably followed the rule for rodent species that the prominent combs anterior of the vulva were followed by inconspicuous spines posterior of it. Frölich's reference to the rare occurrence of teeth behind the vulva bears out this assumption. The writer feels safe, therefore, in adhering to a generic diagnosis of *Rictularia* in which two rows of ventral combs or spines is specified, even with a type-species described as having only one, on the ground that there is ample reason and evidence for believing that the type-species must have had two. I venture to think that a reexamination of the type or other adequate material will confirm this opinion.

So far species of this genus have been recorded only from the small intestine, and this is the only habitat mentioned in the generic diagnosis. However, I have collected a female *Rictularia* from the stomach of a rodent on one occasion.

RICTULARIA SPLENDIDA Hall, 1913.

Specific diagnosis.—*Rictularia*: Close to *R. cahirensis* Jägerskiöld from *Felis domestica* (Egypt), and to *R. affinis* Jägerskiöld from *Felis domestica* and *Vulpes vulpes niloticus* (Egypt). As there seems to be little of specific value that is common to both males and females, the two will be considered separately.

Male.—Length, 4.83 mm.; the maximum width, exclusive of spines, in posterior part of body, 280 μ . Dorso-ventral head diameter at the base of the buccal capsule, 72 μ . Length of esophagus, 1.75 mm. Nerve ring not discernable; 108 or 109 combs, attaining a height of

47 μ and a length of 100 μ along the distal margin in the esophageal region of body, the maximum height being attained in the next to the last comb, which has an apparent height of 70 μ . In the ventral line of the posterior portion of the body, anterior of the cloaca and between the two latero-ventral

lines of combs is a row of 8 fan-shaped, almost semicircular, cuticular structures. (See fig. 1.) These fans are beautifully fluted. The last fan measures 53 μ from its base to its tip and 110 μ along the base. They are set obliquely, the anterior end being to the left of the ventral line and the posterior end being to the right and overlapping the anterior end of the succeeding fan. I find no such relation between the fluting of the fans and the cuticular annulation as Jägerskiöld suspects of being present. The fluting seems to

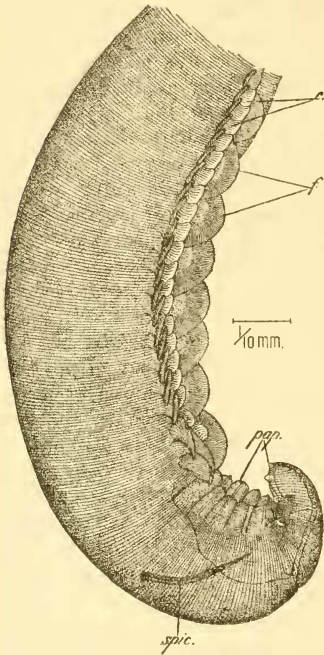


FIG. 1.—RICTULARIA SPLENDIDA. TAIL OF MALE. *c.*, LATERO-VENTRAL COMBS; *f.*, VENTRAL FANS; *pap.*, PAILLE; *spic.*, SPICULES.

be of the same nature as that of the combs. In this region the body of the male is flattened on that portion of the ventral surface included between the latero-ventral combs. (See fig. 2.) The last two or three of these combs are larger than the others and somewhat different in form, a modification which Jägerskiöld thinks is of service in clasping the female. There is a slight bursa membrane, scarcely worthy the name of bursa, and resembling slightly developed caudal alæ. There is only one pair of postanal papillæ visible,

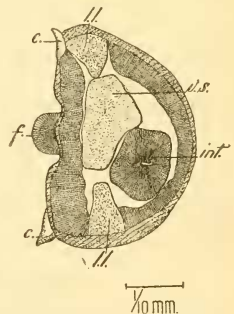


FIG. 2.—RICTULARIA SPLENDIDA. CROSS SECTION, SEMIDIAGRAMMATIC, IN TAIL REGION OF MALE. *c.*, LATERO VENTRAL COMBS; *f.*, MID VENTRAL FANS; *int.*, INTESTINE; *l. l.*, LATERAL LINES; *v. s.*, VESICULA SEMINALIS.

situated near the tip of the tail. Of pre-anal papillæ there are three pairs that show a true papillar structure. These are large conoidal affairs. A pair of somewhat similar cuticular elevations is situated anterior of these and nearer the ventral line, just back of the last ventral fan, but no papillar structure is evident here. The slightly curved, light-colored spicules are equal, 207μ long and 9 or 10μ wide. The width of the cuticular annulations is from 5 to 7μ over most of the body. The mouth has the structure characteristic of the genus: The buccal capsule is bounded on its antero-ventral surface by a lip which overhangs the buccal aperture somewhat; this lip seems to be supported by two chitinous trabeculæ; around the buccal aperture is a row of denticles, not easily counted, but apparently between 15 and 20 in number; at the base of the buccal capsule just

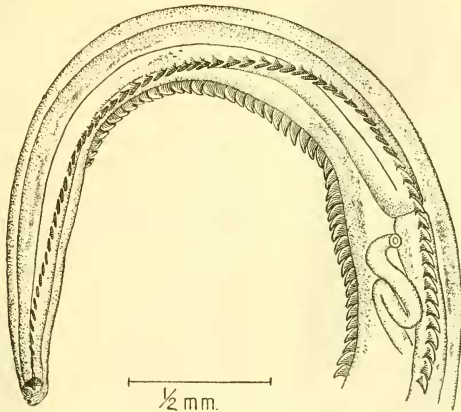


FIG. 3.—*RICTULARIA SPLENDIDA*. ANTERIOR END OF FEMALE SHOWING VULVA.

dorsal of the esophageal aperture is a tooth about 11μ long, curved dorsally at its tip. (Other details of the capsular armature not determined for male. See description of female.) The head papillæ, while doubtless present, are not evident in the male. The anterior end of the first latero-ventral comb is about 30μ back of the base of the buccal capsule.

Female.—Length, 8.37 to 10.55 mm.; maximum diameter, 440μ . Dorso-ventral head diameter at base of the buccal capsule, 80μ . Length of esophagus, 2.53 to 2.91 mm. Distance of nerve ring from anterior end of body, 312μ . Vulva just posterior of the posterior end of the esophagus, 2.33 to 2.49 mm. back of the anterior end of body, and opposite the fifty-fifth comb. (See fig. 3.) Vulva may be situated to right or left of the median ventral line. The transition

from combs to spines is very gradual. I have divided the 136 combs and spines into 120 combs and 16 spines, though this might be shifted one or two either way. In one specimen the apparent total of combs and spines is 138. The combs attain a maximum height of $72\ \mu$ in the neck region. The last spine is about 1.7 mm. from the posterior end of the body. The anus is 180 to $315\ \mu$ from the tip of the tail. In the specimen noted as having 138 combs and spines, there appears

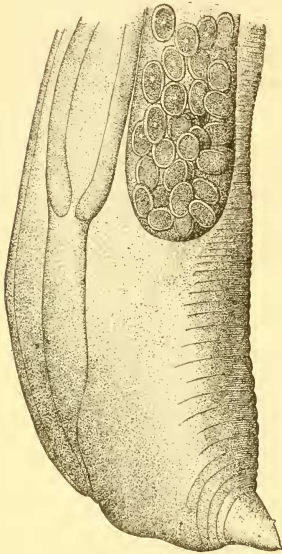


FIG. 4.—*RICTULARIA SPLENDIDA*. TAIL OF FEMALE.

to be a row of 4 very small, anteriorly directed spines close together and just anterior of the anus. While these structures seem unmistakable and hardly apt to be artifacts occurring in orderly, duplicating sequence, it would be interesting to learn whether anything similar occurs on related forms before assuming anything in regard to these. The posterior branch of the uterus may terminate anterior or posterior of the anus. The tail ends in a blunt, rounded end, bearing a short spine. (See fig. 4.) What appears to be a papilla occurs near the end of the tail. In the posterior portion of the body the cuticular annulations are about $5\ \mu$ wide; more anterior they are $7\ \mu$; in some places in the neck region they are about $16\ \mu$. The eggs have shells averaging about 38 to $42\ \mu$ long by 32 to $34\ \mu$ wide and about 3 or 4 μ thick. The eggs contain a well-developed embryo while in utero. The mouth structure is for the most part similar to that of the male. (See figs. 5 and 6.) It is a little larger, the prominent tooth at the base is 16 to $20\ \mu$ long and has on each side of it a pair



FIG. 5.—*RICTULARIA SPLENDIDA*. HEAD OF FEMALE.

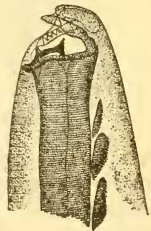


FIG. 6.—*RICTULARIA SPLENDIDA*. HEAD OF FEMALE.

of smaller teeth very likely represented in the male, but not evident in my material. The large tooth seems to be borne on a chitinous projection originating on the dorsal side of the capsule, a condition somewhat similar to that figured by Jägerskiöld for *R. affinis*. There is also another tooth evident toward the ventral side of the base of the capsule from the tooth already noted. The head papillæ are not well defined, and are not represented in the figure. The anterior end of the first latero-ventral comb is about 55 μ back of the base of the buccal capsule.

Host.—*Canis nebracensis*.

Location.—Small intestine.

Locality.—Amo, Colorado, 18 miles east of Colorado Springs.

Type-specimen.—Cat. No. 16218, U.S.N.M. (Bureau of Animal Industry helminthological collection); collected by M. C. Hall, October 3, 1911.

The following key is intended only to show the position of *R. splendida* with relation to the other species of the genus, and hence the majority of the species are covered simply as a group. Part of the characteristics of some species are derived from Jägerskiöld's figures unsupported by any statement in the text, but his excellent figures seem to warrant this.

Key for distinguishing Rictularia splendida from other species.

1. *Females* with cuticular formations anterior of vulva comb-shaped; posterior of vulva they become spine-shaped, the transition being in the region of the vulva and fairly distinct. *Males* with latero-ventral combs not extending posteriorly to the cloacal aperture. *Rictularia* spp. parasitic in bats, insectivores, and rodents.
 - Females* in which the transition from combs to spines is very gradual and remote from the vulva. *Males* with latero-ventral combs extending posteriorly practically to the cloacal aperture. *Rictularia* spp. parasitic in carnivores 2.
2. *Females* with 136 to 138 combs and spines; vulva posterior of esophagus; anterior end of first comb its own length, or farther, from the base of the buccal capsule. *Males* with 8 large midventral fans, almost semicircular in outline, just anterior of cloaca; 108 or 109 latero-ventral combs; 3 pair of large conoidal pre-anal papillæ, spicules 207 μ long. *Rictularia splendida*.
 - Females* with fewer combs and spines or with vulva usually anterior of the posterior end of esophagus; the first comb distinctly less than its own length from the base of the buccal capsule. *Males* with fewer and flatter fans, more or else fewer latero-ventral combs, no large conoidal pre-anal papillæ, spicules distinctly shorter or longer. 3.
3. *Females* with 126 to 135 combs and spines and with vulva always posterior of esophagus. *Males* 4.8 mm. long, with 7 midventral fans, 96 latero-ventral combs, spicules 170 μ long. *Rictularia cahirensis*.
 - Females* with 127 to 137 combs and with vulva usually anterior of posterior end of esophagus. *Males* 7 to 8.5 mm. long, with 6 midventral fans, 111 latero-ventral combs, spicules 220 to 230 μ long. *Rictularia affinis*.

The extent of the latero-ventral combs in the male is hard to judge from descriptions and figures given. It may be that it will not serve to separate the males parasitic in carnivores from those in other host groups.

The females of the three species of *Rictularia* known from carnivores are so very much alike that it is difficult to compile a key for their differentiation, which is the more unfortunate in that the female, as is the rule among nematodes, is the one most likely to be collected and collected in larger numbers.

The following notations will add something of use in differentiation: The female of *R. splendida* is the smallest and that of *R. affinis* the largest, the three species making a series in which the maximum of a smaller species is the minimum of the next larger, as follows: *R. splendida* 8.37 to 10.55 mm., *R. cahirensis* 10.5 to 13.5 mm., *R. affinis* 13.5 to 20.5 mm. The last-named species has also a distinctly longer esophagus than the others, but has smaller eggs. The egg dimensions are as follows: *R. splendida* 38 to 42 μ by 32 to 34 μ , *R. cahirensis* 39 to 42 μ by 26 to 28 μ , *R. affinis* 36 to 38 μ by 24 to 26 μ . Jäger-skiöld figures the first comb of both his species as closer to the base of the buccal capsule than is the case in *R. splendida*, and I have included this distinction in my key. He makes no statement in regard to this point in his text and the distinction may not be found to be a good one.

As regards the males, *R. splendida* and *R. cahirensis* are about the same size, while the male of *R. affinis* is about half as large again. The last-named male also has a longer esophagus, as would be expected, and wider annulations (10 to 14 μ).

Since the parasites of the coyotes, as pointed out in my introductory paragraph, are of considerable economic importance, I have summarized here the records of parasites from coyotes so far as they are known to me.

Protozoa.—*Opalinopsis nucleolobata* was described as a new species from the liver of *Canis latrans* by Smith and Fox (1908). The parasite had set up pathological alterations in the liver of the coyote, which was an inbred specimen from the Philadelphia Zoological Gardens.

Trematoda.—*Amphimerus pseudofelineus* was recorded from the gall ducts of *Canis latrans* at Lincoln, Nebraska, by Ward (1895) under the name of *Distoma felineum*. Later, Ward (1901) transferred this to the genus *Opisthorchis*, making it a new species, *O. pseudofelineus*. Subsequently Barker (1911) transferred it to his new genus, *Amphimerus*.

Cestoda.—*Multiceps multiceps* was reported from the intestine of *Canis nebracensis* at Washington, District of Columbia, by Hall (1911), the infection being experimentally developed by feeding scolices from the gid bladder worm, or cœnurus, of sheep. A second similar case was also reported by Hall (1912*b*).

Tænia pisiformis is here reported for the first time from the intestine of *Canis nebracensis* on the basis of specimens from Montana and

Colorado. The Colorado specimens were reported by Hall (1912a) as *Tænia* sp., owing to the remarkable structure of the hooks on the first specimen examined. Further study has shown that these hooks were anomalies. Other material from the coyote in Montana can not be placed more definitely at this time than as *Tænia* sp. It is practically certain that coyotes are infested by *Tænia hydatigena*, *Multiceps serialis*, and the adult stage of *Cysticercus ovis*, but there are no records of these parasites from the coyote.

Nematoda.—*Ancylostoma caninum* was reported from the intestine of *Canis latrans* at Washington, District of Columbia, by Stiles and Hassall (1894) under the name of *Uncinaria trigonocephala*.

Belascaris sp. was reported from the intestine of *Canis nebracensis* at Amo, Colorado, by Hall (1912a).

Rictularia splendida, described as a new species in this paper, was reported by Hall (1912a) under the name of *Rictularia* sp.

Arthropoda.—*Dermacentor venustus* has been reported from the skin of *Canis lestes* in Montana by Henshaw and Birdseye (1911).

Sarcoptes scabiei lupi has been collected from *Canis latrans* in South Dakota, there being specimens in the collection of the United States Bureau of Animal Industry, and this or a related variety has been spread by artificial means among the coyotes of Montana under the supervision of the State veterinarian, Dr. M. E. Knowles. Something similar is now being attempted in Wyoming. I have found a division of opinion among Montana sheepmen as regards the efficacy of sarcoptic mange as a means of eradicating coyotes, some claiming that it was doing good and others claiming that it was doing no good, or even doing some damage in cases where it was transmitted to sheep dogs.

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